Building India: Evidence from VECM and Causal Analysis between Construction Activities and Economic Growth[#]

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Abstract

The present study investigates whether construction activities (viz. new construction and repair and maintenance construction) enhances the economic growth in India or not. The study uses a unique set of data to empirically examine the relationship between economic growth and value of output of construction (VOC) which further comprises of activities like new construction (NCON) and repair and maintenance (R&M) during the period between 1950-2012 in India. To this end, Johansen Cointegration Tests, Error Correction Model (ECM) and Granger causality tests were employed in order to determine the aforementioned relation. ECM suggests that there is long run relationship between the series. The ECM and Granger Causality results indicate that the economic growth tends to lead the growth in construction activities but not vice versa i.e. there is a uni-directional relationship between construction activities and economic growth. The results corroborate from previous work of developing economies and that findings have policy implications related to long run growth of the Indian economy.

Keywords — Construction Activities, Economic Growth, Error Correction Model, Granger causality, Johansen Cointegration tests

JEL Codes – C01, C32, E01, L74

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I. INTRODUCTION

Construction sector has been always considered as one of the most important sectors in the economies of all countries for its broad and intense linkages with other sectors which stimulate economic development in the country. As pointed by Pietroforte and Gregori (2006), the construction industry's contribution indeed varies during the development process of an economy transforming from a rural agricultural economy into an urban industrial economy and consequently into an urban service economy.

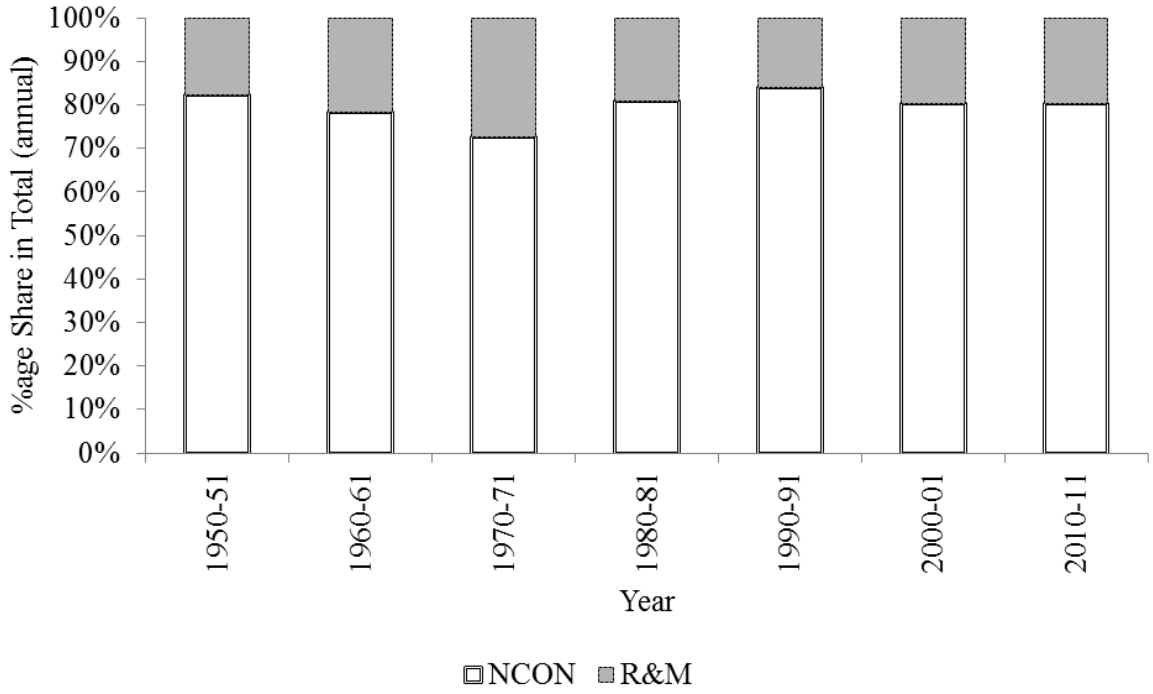
The construction sector has significant impact and is often regarded as a driver of economic growth. A number of scholars like Bon (1990), Lean (2001), et al suggest that construction has a strong linkage with many economic activities and whatever happens to the industry will directly and indirectly influence other industries and ultimately, the wealth of a country. Tse and Ganesan (1997), further recommend that it is possible that expansion of construction activity is preceded by an increase in economic output, with the initial effect felt largely within the construction sector and only subsequently on the aggregate economy. It constitutes an important component of gross domestic product (GDP) and is a major generator of jobs. Hence, the construction industry is regarded as an indispensable and highly noticeable contributor to the process of growth.

According to Wells (1985), the term 'construction' by and large is defined to encompass the creation of physical infrastructure (roads, railways, harbours), other civil-engineering work (dams, irrigation projects, power plants), all building work (including housing), as well as the maintenance and repair of existing structures. As such it is an activity which clearly plays a very vital role in the process of economic growth.

The main objective of present paper is to assess the weight of construction activities on economic growth of India specifically the new construction and repairs and maintenance construction. For this, the study makes use of Value of Output of Construction (VCO) as an indicator of construction activity and GDP as an indicator of economic growth, measured at constant 2004-05 prices. The reason to take VCO as an indicator of construction activity is that it includes both new construction (NCON) and repair and maintenance (R&M) as well. It covers the cost of basic materials, other construction materials and factor payments such as labour cost, rent interest etc.

Figure 1 implies that in India the repair and maintenance activities occupy smaller share in the total construction activities whereas the new construction activities are of greater standing in the country suggesting that construction sector could be of great help for the economic growth of the country.

Figure 1 Share of NCON and R&M in total VOC in India (in %)



Source: http://economicoutlook.cmie.com

Here the relationship between overall growth of the Indian economy and growth of construction sector's activities is examined without considering other factors influencing economic growth rate. The structure of the paper is as follows: the next section provides an overview of construction industry in India. This is followed by a summary of the literature review about empirical analysis of role of construction and economic growth. The data and research methods are then discussed. The subsequent section discusses the findings of empirical analyses. The conclusion and recommendations follows after this section.

II. CONSTRUCTION AND INDIAN ECONOMY

For Indian economy too, the construction sector is one of the core sectors and is by far the single largest contributor to infrastructure. The construction industry has linkages with variety of building material industries like cement, glass, plastic, construction equipment etc. Since

10th five year plan the Government of India planned massive investments on creating physical infrastructure viz. roads (the ambitious Golden Quadrilateral project 2004), housing, transportation, irrigation, urban development, civil aviation etc., which augmented construction demand in the economy. As per the five year planning documents (10th, 11th and 12th) there has been increasing significance of construction activities in the growth of the economy since the component of construction comprises nearly 60% – 80% of the project cost of certain infrastructure projects.

According to the report on working group on construction sector, the Indian construction sector has been contributing around 8% to the nation's GDP (at constant prices) in the last five years (2006-07 to 2010-11).

Table 1 India's Sectoral Compound Annual Growth Rate (% p.a.)

Year	GDP	Agriculture	Industry	Construction	Services
1960-1970	3.55	1.8	5.92	6.2	4.68
1970-1980	2.87	0.96	3.48	1.74	4.39
1980-1990	5.56	4.24	5.95	4.72	6.61
1990-2000	5.78	3.17	5.69	5.57	7.46
2000-2010	7.23	2.37	7.78	9.25	8.7

Source: CMIE – Economic Outlook http://economicoutlook.cmie.com

Table 1, presents compounded annual rate of growth of different sectors that have contributed to India's GDP during planning period. It shows robustness particularly of construction sector as compared to agricultural and industrial sector in India primarily on the account of increased government spending on physical infrastructure in the last few years.

III. LITERATURE REVIEW

Several studies have established theoretical and empirical links between the construction industry and the wider economy. Earlier, Turin (1969) emphasised the momentous role of the construction industry in the national economy on the basis of cross section of data from a

large number of countries at various levels of development by claiming that there is a positive relationship between construction output and economic growth. Ofori (1988) examined relationship between construction industry and Singapore economy and stated that the construction makes a noticeable contribution to the economic output of a country. Later on 'Bon curve' paradigm or inverted U-shaped pattern of development between construction sector and economic growth emerged. Bon (1992, 2000) concluded that construction activity follows an inverted U-shape relationship as an economic system develops from less developed country (LDC) to newly industrializing country (NIC) and to advanced industrialised country (AIC) eventually with time. Crosthwaite (2000) utilised cross sectional analysis and verified the inverted U-shaped relationship between construction spending share in GDP and GDP per capita as advocated by Bon (1992).

Later on new set of studies emerged due to the availability of long time series data and development of econometric methodology like Granger Causality. Tse and Ganesan (1997) by using causality test for the first time found that GDP in Hong Kong tends to lead to construction flows and not vice versa and thus refuting that construction is more volatile than GDP. Green (1997) examined the impact of construction sector through residential and non-residential investment on GDP using Granger causality test. His empirical finding was that residential investment Granger caused GDP, but non-residential construction investment does not Granger cause GDP.

Anaman and Osei-Amponsah (2007) analysed causality link and concluded that growth in construction sector does lead to growth in GDP of Ghana with a lag of three years. Rameezdeen, et al (2006) maintained that construction generates employment and incomes for the people and therefore the effects of changes in the construction industry on the economy occur at all levels and in virtually all aspects of life.

Wong, et al (2008) in their study concluded that construction output specifically infrastructure sector drives the economic growth of the Hong Kong economy and not vice versa and that as economy matures from newly industrialised economy to advanced industrialised economy the role of construction industry changes since more of repair and maintenance work increases while new construction building stock would diminish. Lopes, et al (2011) studied a non-linear relationship between share of construction in GDP and the level of income of per capita for low middle income country Cape Verde over 38 years and concluded that as devel-

oping countries grow the growth pattern of construction industry tend to follow that of the general economy.

In Indian context a couple of such studies have been undertaken viz. Mallick, and Mahalik (2010) investigated the impact of construction sector on economic growth in India in presence of capital stock and it was found that construction sector's impact was blurred. In yet another study, Tiwari (2011) bidirectional Granger causality between construction flows and economic growth in India was founded by incorporating endogenously determined structural breaks.

IV. DATA

According to previous literature reviewed, the relationship of construction activity and economic growth could be bi-directional or uni-directional. Therefore one purpose of this study is to confirm the directional relationship between the variables. The purpose is similar to the previous studies made, but distinct feature of this study is that it makes use of different components of construction activities viz. New construction and Repair and Maintenance to gauge the contribution of construction sector in India.

The present study makes use of Value of Output of Construction (VOC) which comprises of New Construction (NCON), Repair and Maintenance (R&M) as an indicator of construction activity and GDP as an indicator of economic growth, measured at constant 2004-05 prices to evaluate the contribution of construction sector in economic growth of India. The data are mainly sourced and assessed from the official websites of Reserve Bank of India, Ministry of Statistics and Programme Implementation (MOSPI) - National Accounts Statistics published by the Central Statistical Organization (CSO), Centre for Monitoring Indian Economy's (CMIE) Economic Outlook.

V. EMPIRICAL METHODOLOGY

To test whether construction activities stimulates the aggregate economy or the aggregate economy leads construction activity, or if feedback effects between the macroeconomic indicators exist, series' stationary were examined via Augmented Dickey–Fuller (ADF) and Phillips-Perron (PP) unit root tests. Johansen Cointegration Test was employed in order to reveal possible cointegration between series. Error Correction Model (ECM) is then analysed after the identification of cointegration between the series. Lastly Granger causality is applied to define the direction of causality among the series.

A. ADF and PP Unit Root Tests

The conventional ADF (Dickey and Fuller, 1979) and PP (Phillips and Perron, 1988) unit root tests are conducted to test the stationarity of the series so as to ensure that relationship, if any, would not be spurious. The null hypothesis for test was that there was a unit root in the time series. The test is based on the following mathematical formulation:

$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \qquad (1)$$

$$\Delta y_t = \alpha + \delta t + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t \qquad (2)$$

The variable Δy_{t-i} expresses the lagged first differences; u_t adjusts the serial correlation errors the parameters to be estimated. Equation (1) tests for the null hypothesis of a unit root against a mean-stationary alternative whereas equation 2, tests for the null hypothesis of a unit root against a trend-stationary alternative.

B. Johansen-Cointegration Test

The present study will estimate the long run relationship between VOC and GDP; NCON and GDP; R&M and GDP via Johansen Cointegration test. This test is used since it has all desirable statistical properties and therefore is superior test. A vector autoregression (VAR) of order *p* is given by

$$\Delta y_t = \mu + A_1 y_{t-1} + \ldots\ldots + A_p y_{t-p} + \varepsilon_t \qquad (3)$$

where, y_t = *n x 1* vector of variables that are integrated of order one and ε_t = *n x 1* vector of innovation

If the series are cointegrated it proves that the series in long run may converge (in equilibrium relationships), however in short run they may diverge (disequilibrium relationship). This disequilibrium in short run leads to error correction mechanism. Thus through ECM the dynamics in relationship between integrated series is examined. Following is the regression equation for ECM:

$$\Delta Y_t = \alpha + \beta_1 \Delta X_{t-1} + \beta_2 U_{t-1} + \varepsilon_t \qquad (4)$$

where, $U_{t-1} = X_{t-1} - \theta Y_{t-1}$, β_2 = ECM coefficient which should be negative and statistically significant

The ECM (or error correction term – ECT), however, is particularly powerful since it allows an analyst to estimate both short term and long run effects of explanatory time series variables (Ozkan et al 2012)

C. Granger Causality Test

If series, X and Y are individually I*(1)* and cointegrated then Granger causality test may be applied in order to define the direction of causality among series. The perception of 'Causality' is based upon the idea that a cause cannot come after the effect. If a variable X affects Y then it should help improving the predictions of the latter variable. Reference [4] concept of causality was based upon prediction error: "X 'causes' Y if and only if Y is better predicted by using the past history of X than by not doing so with the past Y being used in either case". This is carried out by means of the following formulation:

$$X_t = \alpha_0 + \sum_{i=1}^{m} \alpha_{1i} X_{t-i} + \sum_{i=1}^{n} \alpha_{2i} Y_{t-i} + u_t \qquad (5)$$

$$Y_t = \alpha_0 + \sum_{i=1}^{q} \beta_{1i} Y_{t-i} + \sum_{i=1}^{r} \beta_{2i} X_{t-i} + v_t \qquad (6)$$

where u_t and v_t are zero-mean, serially uncorrelated, random disturbances. The optimum lag lengths m, n, q and r are determined on the basis of Schwarz Bayesian criterion (SBC).

In "(5)" Y Granger causes X if

H_0 $\alpha_{21} = \alpha_{22} = \ldots\ldots\ldots \alpha_{2n} = 0$ is rejected

H_1 at least on $\alpha_{2i} \neq 0$, $I = 1\ldots\ldots\ldots n$

In "(6)" X Granger causes Y if

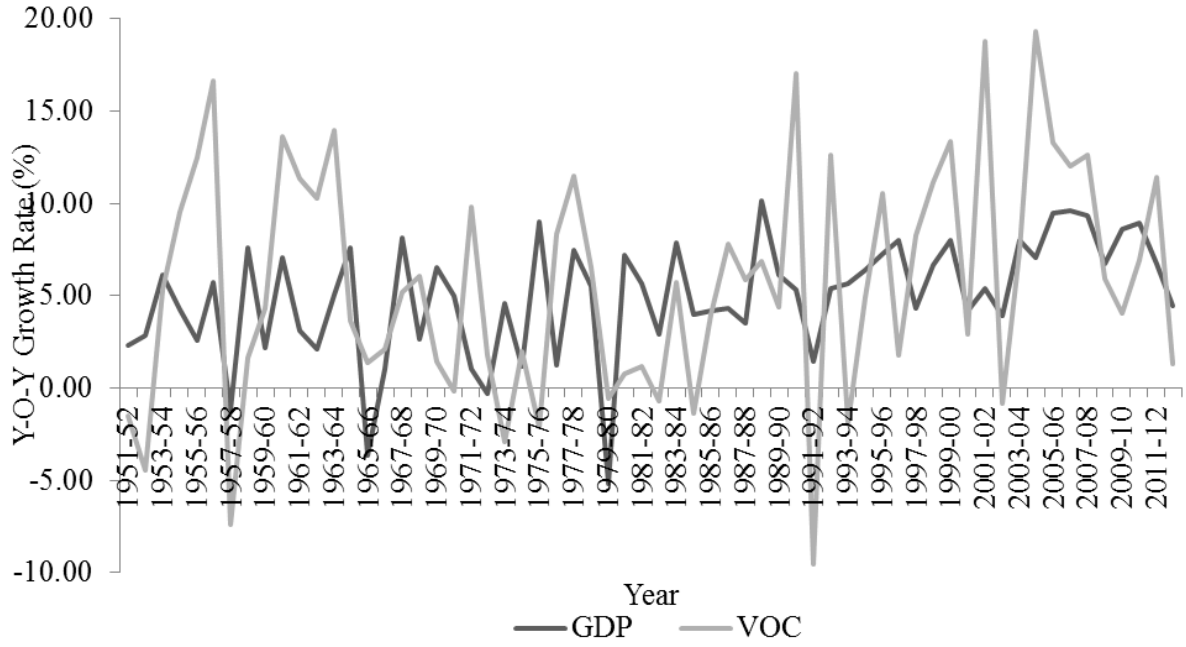
H_0 $\beta_{21} = \beta_{22} = \ldots\ldots\ldots \beta_{2n} = 0$ is rejected

H_1 at least on $\beta_{2i} \neq 0$, $i = 1\ldots\ldots\ldots r$

VI. FINDINGS AND DISCUSSIONS

In order to get a first glance at the relationship between construction activity and the national economy, VOC growth rates and GDP growth rates are plotted over the long period 1951 – 2012 in figure 2. It is clearly reflected from the figure 2 that GDP growth and growth of VOC almost move in similar pattern except for few divergences. In other words, the fall or rise in growth of GDP generally leads to fluctuation in the VOC.

Figure 2 GDP Growth Rate and VOC Growth Rate



Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are used to test the stationary properties of the series. These tests were firstly applied to determine the integrated order of VOC, NCON, R&M, and GDP. Table 2 display the results of unit root tests against trend of all the variables at levels and in first difference.

Table 2 ADF and PP Unit Root Tests at levels and first differences

Variable	ADF	PP
LGDP	0.194474	0.699158
LVOC	-0.58051	-0.58914
LNCON	-0.9797	-0.9797

LR&M	-0.69612	-0.94983
DLGDP	-9.53638*	-9.71241*
DLVOC	-7.69199*	-7.69199*
DLNCON	-8.83361*	-8.83128*
DLR&M	-6.9268*	-6.95208*

*Note: "L" indicates natural logarithm of variables, "D" indicates first difference of variables while * denote rejection of the unit root at 1%, 5% and 10% significance level*
ADF critical values at 1%, 5% and 10% is -4.12, -3.49, -3.17 respectively
PP Critical values at 1%, 5% and 10% is -4.11, -3.48, -3.17 respectively

Table 2 clearly indicates that variables LGDP, LVOC, LNCON and LR&M are not stationary at levels for both ADF as well as PP unit root tests. In opposition, unit root test indicates that LGDP, LVOC, LNCON and LR&M series are stationary in first differences i.e. integrated of order 1 – I(1). After unit root tests the Johansen tests were applied in step wise procedure to check the presence cointegration between the variables in long run.

Table 3 Johansen Cointegration Rank Test (Trace), 1950-2012

Series	No. of CE(s)	Trace Statistics	Max Eigen Value
dlogVOC dlogGDP	None *	25.76363	19.0806
	At most 1 *	6.683032	6.683032
dlogNCON dlogGDP	None *	26.83596	17.71996
	At most 1 *	9.116004	9.116004
dlogR&M dlogGDP	None *	24.60307	20.94459
	At most 1 *	3.658487	3.658487

*Note: * indicates significance at 5% level*

Table 3 reports the results of Johansen trace test for cointegration between the series for full sample. If the null hypothesis of no cointegration vector is rejected it means that there exists a linear combination of the *I (1)* variables in the long-run. Thus the test indicates that first difference between the variables i.e. between VOC, GDP; NCON, GDP and R&M, GDP have long run equilibrium relationship at the 5% significance level.

Table 4 presents long run cointegrating equation results. It is clear from results of cointegration regression that in India due to 1% age growth in value of construction output, the economic growth augments by almost 23% age only. This is quite evident since India also invests in other sectors. It is only since 2002 and more so in the recent times that a bigger proportion of India's annual budget expenditure has been allocated to the construction sector.

Table 4 Results of Cointegration Regression

Dependent Variable: DLOG(GDP)				
Cointegrating equation deterministics: C				
Variable	Coefficient	Std. Error	t-Stat	Prob.
DlogVOC	0.230731	0.064016	3.60425	0.0006
C	0.035605	0.005185	6.866807	0

Since the results indicate that construction activities growth rate and economic growth rate have long run and stable relationship the error correction method (ECM) is applied. It is to be noted that if the value of ECT is significant and negative it means that there is a long run equilibrium relationship between the variables since any disturbance in the next period in the dependent variable would get corrected by the amount of the coefficient value. However, a positive and significant ECT means there is disequilibrium since any disturbance in the dependent variable will diverge from the equilibrium by the amount of coefficient value.

Table 5 displays ECM results. As is evident, when VOC is dependent variable the corresponding value of ECT is -0.0011 indicating that any disturbance in value of VOC in next year gets corrected by 0.11%, i.e. the speed of adjustment is 0.11%. Similarly, in case of GDP as a dependent variable, any disturbance in GDP will get diverge by 1.7% in the next year.

Table 5 Error Correction Model[2]

Dependent Variable	ECT (-1)	Error Correction Estimates

[2]The error correction models in the above table have been tested for Breusch-Godfrey Serial Correlation LM Test and Heteroscedasticity Test: Breusch-Pagan-Godfrey. The test results for all the models show that there is no serial correlation and heteroscedasticity among the residuals of all the models.

DLogVOC	-0.00115 (0.008992)	D(LOGVOC) = - 0.111*D(LOGVOC(-1)) + 0.034*D(LOGVOC(-2)) + 0.317*D(LOGGDP(-1)) + 0.472*D(LOGGDP(-2)) + 0.024 + ECT
DLogGDP	-0.01792* (0.004259)	D(LOGGDP) = 0.0003*D(LOGVOC(-1)) - 0.015*D(LOGVOC(-2)) - 0.332*D(LOGGDP(-1)) - 0.179*D(LOGGDP(-2)) + 0.0742+ ECT
DLogNCON	-0.00582 (0.012437)	D(LOGNCON) = - 0.210*D(LOGNCON(-1)) - 0.021*D(LOGNCON(-2)) + 0.210*D(LOGGDP(-1)) + 0.478*D(LOGGDP(-2)) + 0.036 + ECT
DLogGDP	-0.02245* (0.005314)	D(LOGGDP) = - 0.023*D(LOGNCON(-1)) - 0.030*D(LOGNCON(-2)) - 0.320*D(LOGGDP(-1)) - 0.167*D(LOGGDP(-2)) + 0.075 + ECT
DLogR&M	0.00175 (0.01229)	D(LOGR_M) = - 0.004*D(LOGR_M(-1)) + 0.065*D(LOGR_M(-2)) + 0.754*D(LOGGDP(-1)) + 0.355*D(LOGGDP(-2)) + 0.002 + ECT
DLogGDP	-0.0174* (0.003832)	D(LOGGDP) = 0.063*D(LOGR_M(-1)) + 0.036*D(LOGR_M(-2)) - 0.403*D(LOGGDP(-1)) - 0.271*D(LOGGDP(-2)) + 0.076 + ECT

*Note: * denotes significance at 1% level, t-values are denoted in parentheses*

The Granger Causality test attempts to assess how much of the current GDP growth can be explained by past values of GDP growth rate itself and then to see whether adding lagged value of VOC growth rate can improve the explanation and vice versa. The economic growth is said to be Granger caused by construction activities if VOC activities (NCON or R&M) helps in the prediction of GDP growth or equivalently if the coefficients on the lagged VOC activities (NCON or R&M) are statistically significant. The results of bivariate causality relating the VOC activities (NCON or R&M) and GDP growth rate in India are presented in Table 6.

Table 6 Results Of Bivariate Granger Causality Tests

Null Hypothesis	Obs	Lags	F-statistics	Prob

dlogVOC does not Granger Cause dlogGDP	62	1	0.52781	0.4704
	61	2	0.6803	0.5106
dlogGDP does not Granger Cause dlogVOC	62	1	6.77002*	0.0117
	61	2	3.51197*	0.0366
dlogNCON does not Granger Cause dlogGDP	62	1	0.3169	0.5756
	61	2	0.54735	0.5815
dlogGDP does not Granger Cause dlogNCON	62	1	10.2872*	0.0022
	61	2	4.72885*	0.0127
dlogR&M does not Granger Cause dlogGDP	62	1	0.6119	0.4372
	61	2	1.16834	0.3183
dlogGDP does not Granger Cause dlogR&M	62	1	4.1847*	0.0453
	61	2	3.39175*	0.0407

*Note: *denotes significant at 5% level.*

The bivariate Granger Causality test indicates that construction activities (VOC - NCON and R&M) does not Granger cause the GDP growth as its null hypothesis could not be rejected. Whereas the past values of VOC, NCON and R&M help to predict the GDP growth in India which implies that the rise of GDP leads to increase in construction activities i.e. VOC - NCON and R&M. This means that GDP growth leads the growth in VOC with a 1 or 2 years lag.

In other words the result indicates that increase in GDP leads to expansion of new construction activities with a 2 year lag and growth in repair and maintenance works with 1 year lag. This means that changes in GDP helps to predict changes in the construction activities. On the other hand the results do not show any effect of construction activities growth on the GDP growth. Therefore there is uni-directional relationship between the GDP and construction ac-

tivities. If GDP rises, so will the level of construction activities needed to meet the expanded production capacity.

As pointed out by Turin the mix of construction a demand and output change as an economy develops. So if share of repair and maintenance work rises in total construction output to new construction it means that the economy is a developed economy. For India the trend shows that the share of R&M in total construction output is approximately 19% which has increased marginally over the years indicating a transformation of the product mix in the industry across time.

VII. CONCLUSION AND RECOMMENDATIONS

The present paper tries to gauge the contribution of construction sector in India through a different parameter viz., Value of Output of Construction which further is classified as New Construction and Repairs and Maintenance. This study has carried out an empirical investigation on the direction of causality as well as Johansen Cointegration Tests, Error Correction Model (ECM) tests between the construction activity and aggregate economy of India for the period 1950-2012, to ascertain whether the construction activities can be used to lead the entire economy on a growth path.

The findings of the present study indicate that there is uni-directional relationship between construction activities and economic growth i.e. economic growth leads to growth in construction activity and not vice versa. The cointegration and error correction tests also suggest that there is a long run and stable relationship between the series.

In terms of the relationship between growth of construction activities viz., New Construction and Repair and Maintenance and GDP growth the results corroborate from previous work that countries that are in a sustained process of reaching the industrialised status, the evolution pattern of construction tends to follow that of the general economy. In contrast to the developed countries where the impact of construction sector on business cycles is more powerful, in India, the analysis depicted above clearly demonstrates that the impact of construction sector on business cycles both in the long run and short run is less visible.

The demand for construction work is not autonomous rather it is determined by the level of GDP. Thus an important policy implication is that government should device measures such as to enhance productivity and to augment adequate and easy flow of institutional finance.

Construction activity is very sensitive to credit conditions due to industry's cyclical nature. If the bank credit available to this sector is at cheaper rate and also FDI inflows to this sector increases, it leads to rise to aggregate demand and thereby leading to an increase in construction activity. This rise in construction activity will raise GDP through the multiplier, which in turn leads to a higher demand for construction orders. This would build up the sector's capacity to deliver the critical infrastructure needed for economic development of the country.

This study looks at the construction sector as a whole and does not differentiate between residential and non-residential construction. A future research can be done taking into consideration these two classifications of construction.

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